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(71) Applicant *(for all designated States except US)*: **THE GENERAL HOSPITAL CORPORATION D/B/A MASSACHUSETTS GENERAL HOSPITAL** [US/US]; 55 Fruit Street, Boston, MA 02114 (US).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: **ACKERMAN, Jerome, L.** [US/US]; 111 Blake Street, Newton, MA 02460 (US). **WEDEEN, Van, J.** [US/US]; 33 Willow Ave., Somerville, MA 02194 (US).

(74) Agents: **GEARY, William, C., III** et al.; Nutter McClennen & Fish LLP, World Trade Center West, 155 Seaport Boulevard, Boston, MA 02210-2604 (US).

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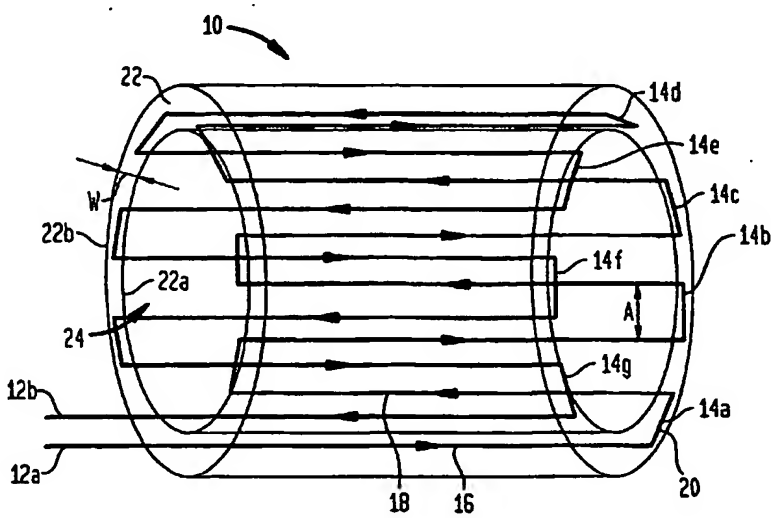
[Continued on next page]

(54) Title: CATHETER AND RADIOFREQUENCY COIL WITH ANNULAR B1 FILED



(57) Abstract: In one aspect, the present invention provides a cylindrical meanderline coil that can significantly improve the performance and usefulness of nuclear magnetic resonance (NMR) catheter radiofrequency (RF) coils by shaping the spatial dimensions of the volume of excitation and reception of signal. This can provide improved accuracy in defining the volume of excitation and reception of the subject or specimen, and increase the signal to noise ratio of a received signal. In another aspect, the invention provides an intravascular catheter having a coil at its tip for generating and/or detecting magnetic excitations. A preamplifer coupled to the catheter in proximity of the coil allows amplifying signals generated and/or detected by the coil. Although in one application, a coil and/or a catheter of the invention can be employed, for example, for MR spectroscopy or imaging of biological tissue, such as atherosclerotic plaques arterial walls in the human body, the invention provides similar advantages in any situation where a magnetic resonance or other magnetic induction signal is to be received from a thin cylindrical shell or sector of a cylindrical shell.

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INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 03/33316

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G01R33/28 G01R33/34

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G01R

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, EMBASE, INSPEC, COMPENDEX, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	HURST G C ET AL: "INTRAVASCULAR (CATHETER) NMR RECEIVER PROBE: PRELIMINARY DESIGN ANALYSIS AND APPLICATION TO CANINE ILIOFEMORAL IMAGING" MAGNETIC RESONANCE IN MEDICINE, ACADEMIC PRESS, DULUTH, MN, US, vol. 24, no. 2, 1 April 1992 (1992-04-01), pages 343-357, XP000275075 ISSN: 0740-3194 Sections "Methods", "Simulations and phantom images", "In vivo canine images"figures 2-4,6,11 -----	1-11, 19-38, 40-43,45
X	ZIMMERMANN GG ET AL: "Intravascular MRI" IN: DEBATIN JF, ADAM G. "INTERVENTIONAL MRI", SPRINGER (1998) , XP002275002 page 283 - page 293 figure 34.1E ----- -/--	1-11, 19-26, 42,43,45

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
5 April 2004	08. 07. 2004

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Streif, J

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INTERNATIONAL SEARCH REPORT

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PCT/US 03/33316

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 196 796 A (REID ERIC D ET AL) 23 March 1993 (1993-03-23) column 2, line 45 - column 5, line 54; figure 1A	1-10,12, 15-17, 19-22, 24-26
X	EP 0 850 595 A (MARCONI GEC LTD) 1 July 1998 (1998-07-01) column 1, line 43 - column 2, line 7 column 3, line 41 - column 4, line 23; figures 2,4	1-10, 19-26
P,X	EP 1 293 793 A (JOMED NV) 19 March 2003 (2003-03-19) paragraphs [0008] - [0015] paragraphs [0030] - [0038]; figure 3	1-10, 19-26
X	US 5 602 557 A (DUERR WILHELM) 11 February 1997 (1997-02-11) column 1, line 47 - column 2, line 8 column 2, line 40 - column 3, line 13; figure 1	1-10,12, 15-17, 19-22, 24-26
X	NAKADA T ET AL: "31P NMR Spectroscopy of the stomach by zig-zag coil" MAGN. RESON. MED., vol. 5, 1987, pages 449-455, XP009027479 page 450; figure 1	21,25,26
X	US 6 326 787 B1 (COWGILL DONALD F) 4 December 2001 (2001-12-04) column 2, line 11 - column 3, line 59 column 5, lines 17-61; figures 3A,3B	21,25,26
X	US 5 572 132 A (PULYER YULY M ET AL) 5 November 1996 (1996-11-05) column 8, lines 11-29; figure 7A	1-12, 14-17, 19-26
X	PATENT ABSTRACTS OF JAPAN vol. 017, no. 349 (C-1078), 2 July 1993 (1993-07-02) & JP 05 049614 A (TOSHIBA CORP), 2 March 1993 (1993-03-02) abstract	12-14, 17,21,25

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INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 03/33316

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	FARRAR CT ET AL: "Use of cylindrical meanderline catheter coils for intravascular imaging" PROCEEDINGS OF THE INTERNATIONAL SOCIETY FOR MAGNETIC RESONANCE IN MEDICINE, 11TH SCIENTIFIC MEETING AND EXHIBITION, TORONTO, CANADA, 10-16 MAY 2003, page 2648, XP002276046 the whole document	1-11, 19-38, 40,41

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 03/33316

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1-38,40-43,45-47

Remark on Protest.

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-38,40-43,45-47

The following inventions a)-c), although not linked by a common inventive concept, could be searched without effort justifying an additional fee:
a) Claims 1-11, 19-38, 40-43, 45
A coil which may comprise a meanderline conductive structure, a medical catheter and a method suitable for magnetic resonance imaging and spectroscopy.
b) Claims 12-18
A coil assembly suitable for RF quadrature operation.
c) Claims 46, 47
A medical catheter comprising a tubular conductive structure.

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2. claim: 39

A medical catheter comprising a coil and comprising a feedback circuit suitable for monitoring and optimizing tuning of said coil.

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3. claim: 44

A method suitable for magnetic resonance imaging and spectroscopy wherein selected nuclei are polarized by a static magnetic field and said selected nuclei are any of phosphorus, carbon, oxygen or sodium.

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4. claims: 48-51

A medical catheter with two operational modes.

INTERNATIONAL SEARCH REPORT

[redacted]nform[redacted]on patent family members

International Application No
P[redacted]03/33316

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